XI. APPENDICES

APPENDIX A

Ballast Water Treatment System
Efficacy Matrix

Twenty-eight ballast water treatment systems were reviewed by Commission staff for compliance with the California performance standards. Only 20 systems had data on system efficacy available for review. System data was examined closely for results comparative to each of the organism size classes. The comparison of results against the performance standards was difficult because of the wide variety of testing procedures and methods of reporting results by treatment system developers. In this initial review, Commission staff was lenient in their assessment of systems that meet the standards. The limited availability of shipboard results of system efficacy required Staff to include results from dockside and laboratory studies in their analysis. In an effort to standardize results, Staff evaluated any data on zooplankton abundance as representative of the largest size class of organisms (greater than 50 µm in size), and phytoplankton abundance was evaluated on par with organisms in the 10 – 50 µm size class. Results presented as percent reduction in organism abundance or as concentration of pigments or biological compounds associated with organism presence were noted, but these metrics were not comparable to the performance standards.

In the following tables, systems with at least one testing replicate in compliance with the performance standard are scored as meeting California standards. Testing results that had no testing replicates in compliance with the standard are scored as not meeting California standards Systems that presented data for a given organism size class but presented the results in metrics not comparable to the standards are classified as “Unknown.” For example, a system that presented results of system effect as percent reduction of zooplankton abundance could not be compared against the California standards, and thus ability of the system to comply with the standards is unknown. Open cells indicate lack of testing or results for a given organism size class. The source(s) of the data for each system can be found in the Literature Cited section of this report.

Appendix A1 Organisms > 50 µm

Manufacturer	Location	# Tests	# Tests Met Std	Replicates	Controls	# Organisms/cubic meter	Methods	Reference
Alfa Laval	Laboratory	1	0	-	-	Unk (% Reduction)	Visual Assesment	54
	Dockside	2	1	3	Y	0 - 11	Visual Assesment	1
	Shipboard	1	1	1-3	N	0	Visual Assesment	54
Degussa AG	Laboratory	2	2	Y	Y	0	Visual Assesment	24, 89
	Dockside	1	0	Y	Y	Unk (% mortality)	Visual Assesment	24
	Shipboard	-	-	-	-	-	-	-
Ecochlor	Laboratory	2	2	2	Y	0 - $3.5x10^5$	Visual Assesment, Neutral Red	63
	Dockside	-	-	-	-	-	-	-
	Shipboard	1	1	3	Y	0-5	Visual Assessment	50
Electrichlor	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-		-	-	-
ETI	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Ferrate Treatment Tech.	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Greenship	Laboratory	-	-	-	-	-	-	-
	Dockside	5	5	Y	Y	0	Visual Assessment	77
	Shipboard	-	-	-	-	-	-	-
Hamann AG	Laboratory	-	-	-	-	-	-	-
	Dockside	6	6	Y	Y	0	Visual Assesment	28, 89
	Shipboard	-	-	-	-	-	-	-
Hi Tech Marine	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	2	0	-	-	Unk (% mortality)	-	31
Hitachi	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Hyde Marine	Laboratory	1	0	Y	Y	-	Visual Assessment	43
	Dockside	4	2	Y, N	Y	0 (100% Mortality)	Visual Assessment	44
	Shipboard	4	0	3	Y	3 - 161	Visual, Neutral Red	99
JAMS	Laboratory	-	-	-	-	-	-	-
	Dockside	4	0	3-5	Y	BD, 2 $x10^5$ - $1.4x10^6$	Visual Assessment	37, 38
	Shipboard	1	0	-	Y	8	Visual Assessment	35
JFE Engineering Corp	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
L. Meyer GMBH	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
MARENCO	Laboratory	-	-	-	-	-	-	-
	Dockside	3	2	Y, N	Y	0 - 1.57	Visual Assessment	39, 40, 96
	Shipboard	-	-	-	-	-	-	-

Appendix A1 Organisms > 50 µm

Manufacturer	Location	# Tests	# Tests Met Std	Replicates	Controls	# Organisms/cubic meter	Methods	Reference
Maritime Solutions Inc.	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
MH Systems	Laboratory	1	0	3	N	Unk (No Units)	Visual Assessment	32
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Mitsubishi Heavy Ind.	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
NEI	Laboratory	-	-	-	-	-	-	-
	Dockside	2	1	Y	Y	0, Unk (% Survival)	Visual Assessment	80, 81
	Shipboard	2	1	Y	Y	0 - 7	Visual Assessment	82
NKO	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Nutech O3 Inc.	Laboratory	3	0	4	Y	$1.2x10^2$ - $1.2x10^4$	Visual Assessment	68
	Dockside	3	1	Y	Y	Unk (% Live)	Visual Assessment	30
	Shipboard	-	-	-	-	-	-	-
OceanSaver	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	9	1	-	Y	0 - 9720	Visual Assessment, Unknown	3
OptiMarin	Laboratory	1	0	-	Y	> 0	Visual Assessment	93
	Dockside	1	0	-	Y	Unk (% Reduction)	Visual Assessment	7
	Shipboard	7	0	Y	Y	1.4 - ~5500, Unk (% Reduction)	Visual Assessment	7, 95
Resource Ballast Tech	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
RWO Marine Water Tech	Laboratory	1	1	-	-	0	Visual Assessment	56
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
SeaKleen	Laboratory	1	1	Y	Y	0	Visual Assessment	14, 26
	Dockside	2	2	3	Y	0	Visual Assessment	44
	Shipboard	1	1	3	Y	0	Visual Assessment	4
Severn Trent	Laboratory	-	-	-	-	-	-	-
	Dockside	5	3	3-4	Y	0 - ~$4x10^5$	Visual Assessment	29
	Shipboard	-	-	-	-	-	-	-
Techcross Inc.	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	1	1	Y	Y	0	Unk	84

Unk = Unknown

BD = Below Detection Limits

Appendix A2 Organisms 10 - 50 µm

Manufacturer	Location	# Tests	# Tests Met Std	Replicates	Controls	# Organisms/ml	Methods	Reference
Alfa Laval	Laboratory	1	0	-	-	Unk (% Reduction)	Visual Assesment	54
	Dockside	2	0	3	Y	0.2 - 0.7	Visual Assesment	1
	Shipboard	1	0	1-3	N	0.407 - 0.943	Visual Assesment	54
Degussa AG	Laboratory	3	3	Y	Y	0 (100% Mortality)	Visual Assessment, Sytox Green	24, 26, 89
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Ecochlor	Laboratory	2	0	2	Y	<0.1 - >60, Unk ([Chl a])	Visual Assessment, MPN, [Chl a]	63
	Dockside	-	-	-	-	-	-	-
	Shipboard	1	1	3	Y	0-81	Visual Assessment, [Chl a]	50
Electrichlor	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
ETI	Laboratory	-	-	-	-	-	-	-
	Dockside	3	0	2-3	Y	1 - 1.5	Growout (+, -), Flowcam	47, 48, 49
	Shipboard	-	-	-	-	-	-	-
Ferrate Treatment Tech.	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Greenship	Laboratory	-	-	-	-	-	-	-
	Dockside	5	3	Y	Y	0 - 7	Total Counts	77
	Shipboard	-	-	-	-	-	-	-
Hamann AG	Laboratory	-	-	-	-	-	-	-
	Dockside	6	5	Y	Y	0	FCM	28, 89
	Shipboard	-	-	-	-	-	-	-
Hi Tech Marine	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	2	0	-	-	Unk (% Mortality)	-	31
Hitachi	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Hyde Marine	Laboratory	1	0	Y	Y	26 - 210	Visual Assessment, Coulter, MPN	43
	Dockside	4	0	Y	Y	Unk ([Chl a])	[Chl a]	44
	Shipboard	5	0	3	Y	Unk (% of controls, [Chl a])	Visual Assessment, [Chl a]	99
JAMS	Laboratory	-	-	-	-	-	-	-
	Dockside	4	0	3-5	Y	BD, 206.6 - 387.4, Unk	Visual Assessment (20 - 50um)	37, 38
	Shipboard	1	0	-	Y	BD	Visual Assessment	35
JFE Engineering Corp	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
L. Meyer GMBH	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
MARENCO	Laboratory	-	-	-	-	-	-	-
	Dockside	3	0	Y	Y	0.05 - 0.186	MPN, [Chl a], ^{14}C, PAM	39, 40, 96
	Shipboard	-	-	-	-	-	-	-

Appendix A2 Organisms 10 - 50 µm

Manufacturer	Location	# Tests	# Tests Met Std	Replicates	Controls	# Organisms/ml	Methods	Reference
Maritime Solutions Inc.	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
MH Systems	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Mitsubishi Heavy Ind.	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
NEI	Laboratory	-	-	-	-	-	-	-
	Dockside	3	0	Y	Y	Unk	[Chl a]	80, 81
	Shipboard	2	0	Y	Y	443 - 593	Total Counts (Preserved), [Chl a], Regrowth	82
NKO	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Nutech O3 Inc.	Laboratory	3	0	4	Y	Unk	[Chl a]	68
	Dockside	2	0	Y	Y	22 - 190	Total Counts (Preserved)	30
	Shipboard	-	-	-	-	-	-	-
OceanSaver	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
OptiMarin	Laboratory	1	0	-	Y	26 - 210	MPN, Coulter	93
	Dockside	1	0	-	Y	Unk (% Reduction)	[Chl a], Counts, Growout	7
	Shipboard	10	0	Y	Y	Unk ([Chl a], % Reduction)	[Chl a], HPLC, PAM, Counts, Growout	7, 95
Resource Ballast Tech	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
RWO Marine Water Tech	Laboratory	1	1	-	-	0	Visual Assessment	56
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
SeaKleen	Laboratory	2	1	Y	Y	0, Unk (Unitless)	Epifluorescence, Hemacytometer, Sytox Green	14, 26
	Dockside	2	0	3	Y	Unk ([Chl a])	[Chl a]	44
	Shipboard	1	1	3	Y	0	Visual Assessment, [Chl a], Growout	4
Severn Trent	Laboratory	-	-	-	-	-	-	-
	Dockside	5	2	3-4	Y	0.002 - 10, BD ([Chl a])	MPN, [Chl a]	29
	Shipboard	-	-	-	-	-	-	-
Techcross Inc.	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	2	2	Y	Y	0	Unk	84

Unk = Unknown
BD = Below Detection Limits
MPN = Most Probable Number

Appendix A3 Organims < 10 µm

Manufacturer	Location	# Tests	# Tests Met Std	Replicates	Controls	# Organisms/100 ml	Methods	Reference
Alfa Laval	Laboratory	1	0	-	-	Unk (% Reduction)	Visual Assesment	54
	Dockside	2	0	3	Y	$4x10^3$ - $4x10^8$	Visual Assesment	1
	Shipboard	-	-	-	-	-	-	-
Degussa AG	Laboratory	2	0	Y	Y	$3.8x10^7$ - $4.6x10^7$	Plate Counts, PicoGreen	89
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Ecochlor	Laboratory	2	1	2	Y	0,Unk (% of control, % Plate cover)	Plate Counts, ^{3}H-leucine	63
	Dockside	-	-	-	-	-	-	-
	Shipboard	1	0	3	Y	BD	Plate Counts, ^{3}H-leucine	50
Electrichlor	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
ETI	Laboratory	1	0	3	Y	-	Plate Counts, BacLight	46
	Dockside	3	0	2-3	Y	$5x10^7$ - $1x10^9$	Growout (+, -), FCM/PicoGreen	47, 48, 49
	Shipboard	-	-	-	-	-	-	-
Ferrate Treatment Tech.	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Greenship	Laboratory	-	-	-	-	-	-	-
	Dockside	5	2	Y	Y	0 - 6000	Unk	77
	Shipboard	-	-	-	-	-	-	-
Hamann AG	Laboratory	-	-	-	-	-	-	-
	Dockside	1	0	Y	Y	$3.8x10^7$ - 4.6 x 10^7	PicoGreen	89
	Shipboard	-	-	-	-	-	-	-
Hi Tech Marine	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Hitachi	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Hyde Marine	Laboratory	1	0	Y	Y	~5000 - 7000	Plate Counts	43
	Dockside	2	0	Y	Y	Unk	Plate Counts, AODC	44
	Shipboard	4	0	3	Y	Unk	Plate Counts	99
JAMS	Laboratory	-	-	-	-	-	-	-
	Dockside	2	0	3	Y	BD, Unk	Plate Counts	37
	Shipboard	1	0	-	Y	BD	Plate Counts	35
JFE Engineering Corp	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
L. Meyer GMBH	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
MARENCO	Laboratory		-	-	-	-	-	-
	Dockside	3	1	Y	Y	0 - ~$5x10^8$	Plate Counts, Membrane Filtration	39, 40, 96
	Shipboard	-	-	-	-	-	-	-

Appendix A3 Organims < 10 µm

Manufacturer	Location	# Tests	# Tests Met Std	Replicates	Controls	# Organisms/100 ml	Methods	Reference
Maritime Solutions Inc.	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
MH Systems	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Mitsubishi Heavy Ind.	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
NEI	Laboratory	-	-	-	-	-	-	-
	Dockside	2	0	Y	Y	> $1x10^{8}$	FCM	80, 81
	Shipboard	2	0	Y	Y	$7.3x10^{7}$ - $7.9x10^{7}$	FCM	82
NKO	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Nutech O3 Inc.	Laboratory	3	3	4	Y	$\leq 10^{1}$ - 10^{8}	Plate Counts, Membrane Filtration	68
	Dockside	3	3	Y	Y	$3x10^{-1}$ - $3x10^{2}$	Plate Counts, Membrane Filtration	30
	Shipboard	-	-	-	-	-	-	-
OceanSaver	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
OptiMarin	Laboratory	2	0	-	Y	~ $5x10^{3}$ - ~$7x10^{3}$	Plate Counts	93
	Dockside	1	0	-	Y	Unk (% Reduction)	Plate Counts	7
	Shipboard	10	0	Y	Y	$<10^{3}$ - 10^{4}, Unk (% Reduction)	Plate Counts, SYBR Gold	7, 95
Resource Ballast Tech	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
RWO Marine Water Tech	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
SeaKleen	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	1	0	3	Y	Unk (Unitless)	Plate Counts	4
Severn Trent	Laboratory	-	-	-	-	-	-	-
	Dockside	5	3	3-4	Y	<1 - 10^{10}	Plate Counts, Membrane Filtration	29
	Shipboard	-	-	-	-	-	-	-
Techcross Inc.	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	2	2	Y	Y	0	Unk	84

Unk = Unknown
AODC = Acridine Orange Direct Counts
FCM = Flow Cytometer

Appendix A4 *E. Coli*

Manufacturer	Location	# Tests	# Tests Met Std	Replicates	Controls used	# Organisms/100 ml	Methods	Reference
Alfa Laval	Laboratory	1	0	-	-	Unk (% Reduction)	-	54
	Dockside	2	2	3	Y	0.3 - 800	-	1
	Shipboard	-	-	-	-	-	-	-
Degussa AG	Laboratory	1	1	Y	-	0	Plate Counts	26
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Ecochlor	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	1	1	3	Y	0 - ~21	Indexx Labs Colilert	50
Electrichlor	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
ETI	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Ferrate Treatment Tech.	Laboratory	1	0	-	-	300	Indexx Labs QuantiTray MPN	15
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Greenship	Laboratory	1	1	-	Y	>1000 - 3000	Plate Counts	16
	Dockside	5	5	Y	Y	0 - 1	Unk	77
	Shipboard	-	-	-	-	-	-	-
Hamann AG	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Hi Tech Marine	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Hitachi	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Hyde Marine	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	4	4	3	Y	0	Indexx Labs Colisure	99
JAMS	Laboratory	-	-	-	-	-	-	-
	Dockside	2	0	3	Y	BD, Unk	Plate Counts	37
	Shipboard	-	-	-	-	-	-	-
JFE Engineering Corp	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
L. Meyer GMBH	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
MARENCO	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-

Appendix A4 *E. Coli*

Manufacturer	Location	# Tests	# Tests Met Std	Replicates	Controls used	# Organisms/100 ml	Methods	Reference
	Laboratory	-	-	-	-	-	-	-
Maritime Solutions Inc.	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
	Laboratory	-	-	-	-	-	-	-
MH Systems	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
	Laboratory	-	-	-	-	-	-	-
Mitsubishi Heavy Ind.	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
	Laboratory	-	-	-	-	-	-	-
NEI	Dockside	1	1	Y	Y	10 - 160	Indexx Labs MPN Kit	80, 81
	Shipboard	1	1	Y	Y	<100	Indexx Labs MPN Kit	82
	Laboratory	-	-	-	-	-	-	-
NKO	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
	Laboratory	-	-	-	-	-	-	-
Nutech O3 Inc.	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
	Laboratory	-	-	-	-	-	-	-
OceanSaver	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
	Laboratory	-	-	-	-	-	-	-
OptiMarin	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
	Laboratory	-	-	-	-	-	-	-
Resource Ballast Tech	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
	Laboratory	-	-	-	-	-	-	-
RWO Marine Water Tech	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
	Laboratory	1	1	Y	Y	0	Culture Growth	26
SeaKleen	Dockside	-	-	-	-	-	-	-
	Shipboard	1	Unk (0 in control)	3	Y	0 (treatment & control)	Idexx Labs Colisure	4
	Laboratory	-	-	-	-	-	-	-
Severn Trent	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
	Laboratory	-	-	-	-	-	-	-
Techcross Inc.	Dockside	-	-	-	-	-	-	-
	Shipboard	1	1	Y	Y	0	Unk	84

Unk = Unknown

BD = Below Detection Limits

Appendix A5 Intestinal Enterococci

Manufacturer	Location	# Tests	# Tests Met Std	Replicates	Controls	# Organisms/100 ml	Methods	Reference
	Laboratory	-	-	-	-	-	-	-
Alfa Laval	Dockside	2	2	3	Y	0 - 4	-	1
	Shipboard	-	-	-	-	-	-	-
	Laboratory	-	-	-	-	-	-	-
Degussa AG	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
	Laboratory	-	-	-	-	-	-	-
Ecochlor	Dockside	-	-	-	-	-	-	-
	Shipboard	1	0	3	Y	Unk	Indexx Labs Enterolert	50
	Laboratory	-	-	-	-	-	-	-
Electrichlor	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
	Laboratory	-	-	-	-	-	-	-
ETI	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
	Laboratory	1	0	-	-	80	Indexx Labs QuantiTray MPN	15
Ferrate Treatment Tech.	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
	Laboratory	-	-	-	-	-	-	-
Greenship	Dockside	5	5	Y	Y	0	Unk	77
	Shipboard	-	-	-	-	-	-	-
	Laboratory	-	-	-	-	-	-	-
Hamann AG	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
	Laboratory	-	-	-	-	-	-	-
Hi Tech Marine	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
	Laboratory	-	-	-	-	-	-	-
Hitachi	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
	Laboratory	-	-	-	-	-	-	-
Hyde Marine	Dockside	-	-	-	-	-	-	-
	Shipboard	4	Unk (0 in control)	3	Y	0 (treatment & control)	Indexx Labs Enterolert	99
	Laboratory	-	-	-	-	-	-	-
JAMS	Dockside	2	0	3	Y	BD, Unk	Plate counts	37
	Shipboard	-	-	-	-	-	-	-
	Laboratory	-	-	-	-	-	-	-
JFE Engineering Corp	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
	Laboratory	-	-	-	-	-	-	-
L. Meyer GMBH	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
	Laboratory	-	-	-	-	-	-	-
MARENCO	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-

Appendix A5 Intestinal Enterococci

Manufacturer	Location	# Tests	# Tests Met Std	Replicates	Controls	# Organisms/100 ml	Methods	Reference
Maritime Solutions Inc.	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
MH Systems	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Mitsubishi Heavy Ind.	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
NEI	Laboratory	-	-	-	-	-	-	-
	Dockside	1	0	Y	Y	36	Indexx Labs MPN Kit	80, 81
	Shipboard	2	2	Y	Y	<10	Indexx Labs MPN Kit	82
NKO	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Nutech O3 Inc.	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
OceanSaver	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
OptiMarin	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Resource Ballast Tech	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
RWO Marine Water Tech	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
SeaKleen	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	1	Unk (0 in control)	3	Y	0 (treatment & control)	Idexx Labs Enterolert	4
Severn Trent	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Techcross Inc.	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	1	1	Y	Y	0	Unk	84

Unk = Unknown

BD = Below Detection Limits

Appendix A6 ***Vibrio cholerae***

Manufacturer	Location	# Tests	# Tests Met Std	Replicates	Controls	# Organisms/100 ml	Methods	Reference
Alfa Laval	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Degussa AG	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Ecochlor	Laboratory	2	2	2	Y	0 (% cover)	Plate Counts	63
	Dockside	-	-	-	-	-	-	-
	Shipboard	1	0	3	Y	BD - ~1000	Unk	50
Electrichlor	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
ETI	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Ferrate Treatment Tech.	Laboratory	1	0	-	-	108	Indexx Labs QuantiTray MPN	15
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Greenship	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Hamann AG	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Hi Tech Marine	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Hitachi	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Hyde Marine	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
JAMS	Laboratory	-	-	-	-	-	-	-
	Dockside	2	0	3	Y	BD, Unk	Plate Counts	37
	Shipboard	-	-	-	-	-	-	-
JFE Engineering Corp	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
L. Meyer GMBH	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
MARENCO	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-

Appendix A6 ***Vibrio cholerae***

Manufacturer	Location	# Tests	# Tests Met Std	Replicates	Controls	# Organisms/100 ml	Methods	Reference
Maritime Solutions Inc.	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
MH Systems	Laboratory	1	0	3	N	Unk (% Reduction)	Plate Counts	32
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Mitsubishi Heavy Ind.	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
NEI	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	1	1	Y	Y	0	DFA	82
NKO	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Nutech O3 Inc.	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
OceanSaver	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
OptiMarin	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Resource Ballast Tech	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
RWO Marine Water Tech	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
SeaKleen	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Severn Trent	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Techcross Inc.	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	1	1	Y	Y	0	Unk	84

Unk = Unknown
BD = Below Detection Limits
DFA = Direct Fluorescent Antibody

Appendix A7 Virus Like Particles

Manufacturer	Location	# Tests	# Tests Met Std	Replicates	Controls	# Organisms/100 ml	Methods	Reference
Alfa Laval	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Degussa AG	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Ecochlor	Laboratory	2	1	2	Y	0,Unk (% of Control)	Plaque Forming Units	63
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Electrichlor	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
ETI	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Ferrate Treatment Tech.	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Greenship	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Hamann AG	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Hi Tech Marine	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Hitachi	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Hyde Marine	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
JAMS	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
JFE Engineering Corp	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
L. Meyer GMBH	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
MARENCO	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-

Appendix A7 Virus Like Particles

Manufacturer	Location	# Tests	# Tests Met Std	Replicates	Controls	# Organisms/100 ml	Methods	Reference
Maritime Solutions Inc.	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
MH Systems	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Mitsubishi Heavy Ind.	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
NEI	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
NKO	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Nutech O3 Inc.	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
OceanSaver	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
OptiMarin	Laboratory	-	-	-	-	-	-	-
	Dockside	1	0	-	Y	Unk (% Reduction)	Spiked Coliphage MS2 Exp.	7
	Shipboard	5	0	-	Y	Unk (% Reduction)	Spiked Coliphage, SYBR Gold	7, 95
Resource Ballast Tech	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
RWO Marine Water Tech	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
SeaKleen	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Severn Trent	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-
Techcross Inc.	Laboratory	-	-	-	-	-	-	-
	Dockside	-	-	-	-	-	-	-
	Shipboard	-	-	-	-	-	-	-

Unk = Unknown

APPENDIX B

CSLC Treatment Technology Assessment Workshop
Participants and Notes
May 25, 2007
MIT, Cambridge, MA

Participants

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Summary

The workshop was convened by the California State Lands Commission Marine Invasive Species Program to assess the efficacy, availability, and environmental/water quality impacts of ballast water treatment technologies.

A variety of methods exist to treat ballast water. Filtration or mechanical separation is the primary method of separating out large particles, but filtration alone is not sufficient to meet California discharge standards. Biocides provide the means to effectively kill or inactivate all size classes and types of organisms in ballast water, but the potential for environmental impacts associated with the release of biocide treated ballast water is high if proper dosing curves and deactivation steps are not followed. The biological efficacy of these treatment methods must also be balanced against considerations for shipboard use of complete treatment systems, including: crew and vessel safety, volume and flow rate of ballast water to be treated, impact on piping system and ballast tank corrosion rates, energy requirements, integration with ships systems, and space required for treatment machinery.

In terms of biological efficacy, the general consensus was that most treatment technologies, particularly those using biocides, will be capable of meeting the California discharge standards. However, two major challenges associated with assessing treatment efficacy need to be addressed: 1) the lack of available results demonstrating treatment system performance at appropriate vessel-size scale, and 2) the lack of standardized tests and procedures necessary to determine whether or not treated ballast water meets the performance standards.

The development and installation of treatment technologies on operational vessels is not only hampered by issues of biological efficacy but also by lack of system availability. Availability may be defined as a combination of: a) commercial availability of a given system (i.e. is such system available for purchase from a treatment company?), b) the presence of an available market for treatment technologies, and c) certifications (Type Approval) for these systems. While some technologies are close to, or ready, for purchase, the treatment technology marketplace is not yet in place due, in large part, to the lack of system approval mechanisms. At this time, the IMO Ballast Water Management Convention is not ratified, and the United States is still working through the development of processes and criteria for approval of treatment technologies and new legislation regarding performance standards. Until a federal or ratified international certification process comes online, shipping companies will be hesitant to purchase treatment systems with little or no assurance that the system will be permitted to operate in US waters. The market for treatment technologies will remain on hold until the certification and legislative issues are settled, and the timing remains unclear.

The assessment of environmental impacts associated with the release of treated ballast water will require agreed upon whole-effluent testing procedures and criteria. The development of these procedures will require involvement by local, state, and federal agencies with water quality jurisdiction and expertise, and thus far, this involvement has been lacking. However, as a beginning point, many of the active substances/biocides

used in ballast water treatment systems are already in use in other waste water and industrial applications. Therefore, assessment of treatment technologies for toxicological impacts may be eased by an initial examination of current discharge criteria for industrial and storm water permits. The State of Washington also has a ballast water specific whole effluent toxicity test program. Only a few "new" chemicals not currently in use in large-scale applications will require chemical registration and a full toxicological impact analysis before assessment can progress.

Additional topics discussed during the workshop included numbers of vessels that will be impacted by the implementation schedule and the rational behind California's performance standards.

Based upon information presented during the workshop, CSLC staff must take the following next steps to continue to assess the efficacy, availability, and environmental/water quality impacts of ballast water treatment technologies:

- Gather more detailed information on the shipboard development, installation and testing of treatment technologies
- Begin consultation with scientists regarding the development and standardization of tests and protocols to assess treatment technology efficacy relative to California discharge standards

- Continue discussion with USCG and assist where possible in the development of federal performance standards and procedures to approve treatment technologies

- Continue support of installation, testing, and monitoring of full-scaled experimental treatment technology

- Gather information from State and Regional Waterboards on industrial and storm water permits and TMDLs relevant to chemicals used in ballast water treatment technologies

Workshop Notes

Welcome and introductions

Nicole's overview - slides

- Coastal Ecosystems Protection Act requiring performance standards –
    - Currently going through regulatory process.
    - Required to submit report by 2008 assessing treatment technologies. If not available, why not?

- Began process of gathering information a few months ago.
- Matrix overview, IMO docs, peer review, lab tests, ship tests, company documents. Lots of information. Not all extremely clear.

Question (Jon): is there a component for approvals in CA laws?

Maurya: law does not include an approval process, but in reality, we'll need regulations to assist us in determining if a system meets a standard. We have to find a process to assess if a technology meets standards. We are still working out the details of implementation.

- After submission of report, the legislature will determine what (if anything) to do about standards. CSLC has no authority to change the implementation schedule or standard, even based on this assessment.
- Assessment status
  - Matrix assembled. This is the expert panel portion of the bill. We'll meet with the TAG that put original 2006 report together. Based on all input, will put a technology review report together and submit to leg by Jan 1 2008.
- Challenges (went through bullets on slide)
- Performance Standards table slide – noted that WA has % based reductions

Question: What should we be expecting with regard to new builds?

- Kevin: In general, new construction shipyards are booked solid for the next 5 years. To get a rough estimate of the number of new builds (vessel constructed within the last one year) arriving at a given port, one could, take number of current ship calls and divide by 20. This will vary by vessel type and trade, but considers that vessels construction is on a 20 year cycle, particularly the ships calling to CA (operators are generally better, and will pull them out after 20 years service). Services such as *Fairplay* have data on ship age, new build contracts and projections, and has processed the data by type, trade, etc.
- Greg: Could do a demographic analysis on CA with Fairplay data.
- Jon: Trade is doubling (tonnage of ships) on a 10 year cycle. CA is probably the same. High price of scrap metal has fueled rapid retiring of old vessels, and an increase in new builds. This may increase the number of new builds even more.
- Rich: Have seen estimates for the number of new builds based on these data (Fairplay) that are all over the place. Doesn't know if we'll be able to analyze the data and get the information we're looking for.
- Jon: The industry will want pieces of information: Are technologies available to put on my ship? Yards want to know if they can install them on the ship. If there's a problem, is there someone who can install it or fix it for me?
- Kevin: But they can't order technologies without type approval.

- Rich: There could be class approval system (type approval), since CA isn't required to do approvals any specific way.
- Kevin: There are differences between class society requirements and environmental requirements. The American Bureau of Shipping (ABS) has indicated that they can offer a conditional approval, reviewing the mechanical, electrical, structural elements. But this approval would not consider the environmental or efficacy requirements, and would be voided when the environmental process for approval came out. Regarding implementation dates, does California use the same definition as the IMO? For example, "delivery" date is different from a "keel laid" date. Assuming an 18 month build cycle, vessels with "keels laid" in 2009 wouldn't be delivered until mid-2010. Treatment technologies would need to be delivered in the middle of the construction process. It will be a challenge for technology developers [to ramp up the infrastructure] to deliver the quantity of systems which will be needed. Implementation efforts need to consider the difference between keel laid and delivery dates, and the time it will take technology to respond to market demand.
- Jon: Asked for clarification on grandfathering in CA law.
- Maurya: Vessels accepted into either SLC or USCG programs by 2008, are good for 5 years. She noted that originally, author of bill didn't want grandfathering.

Efficacy Questions: Will any technology meet the CA standard?

- Greg: (question) What if there's a technology that meets the standard for one organism but not others? Is there anything that CSLC has to say about it?
- Maurya: would like to get input from those doing the work. In report, would like to know, so we can put in report and include considerations in report.
- Junko: How were numbers decided for bacteria and viruses?
- Greg: Current numbers of bacteria were examined in exchanged ballast water, and the standards dropped this number down several orders of magnitude. A similar process was used for all other categories. The rationale was that technologies needed to be a significant improvement on exchange. The TAG looked at concentrations of organisms with no exchange, proper exchange, and then estimates on treatment technology requirements. The discussion/selection of standards was somewhat open after those. We do not know the shape of the dose response curve, so we could not base the standards on that. A standard based on this curve would've been the "right" number, but no one can answer that question at this point.
- Tom: How were numbers chosen for viruses and bacteria? (33 or 126) They seem baseless. [Info after workshop: E. coli and enterococci numbers come from the EPA recreational contact water quality criteria. http://www.epa.gov/waterscience/beaches/rules/bacteria-rule-final-fs.htm]

- Rich: These are existing water quality standards for U.S. waters (recreational use) for indicator organisms. The bacteria IMO numbers come from EU requirements for water quality.
- Tom: We are not equipped to answer questions on why these standards were selected for microbes. We need pat answers for why these numbers were chosen for the vendors.
- Rich: Thought they came from EPA recreational contact number. The EPA standards are means, coupled with a particular sampling structure behind them – that's why they seem a bit odd. When they [means] were plugged into the IMO standard, the statistical considerations were left out, and that's where these numbers come from.
- Maurya: These were also the numbers in federal legislation at the time - SB 1224, and HB in 2005. She noted that a certain part of advisory panel wanted IMO numbers cut in half.
- Jon: If those are the numbers that can't be changed, we need to determine how to determine if an existing technology meets them. Suggests looking at 2 things: data the developers used to evaluate their systems. The question then becomes, how do you interpolate existing body of numbers to determine that anything meets it [the standard]. There's lots of water treatment techniques (more specifically chemicals) that will meet it, but will kill surrounding environment. That's a whole different question – can it meet it the way we want it to?
- Tom: The matrix here answers these questions. Over ¾ of them are the same chemical. ¼ are non-chemical filter things. Then there are a few others. There are really only a few technologies out there. If you lump these, you're really talking about a single class of compounds. Over ¾ of what you got can clearly achieve the standard. But the active substance issue puts another twist on it. Non-oxidizing chemical can meet the standards (Seakleen, etc) - coffee can do it if you use enough. Any of the biocides can do it. The filter ones won't be able to do it by themselves, given the size range of organisms involved. Almost need to answer these questions by degrees.
- Maurya: We need to consider that the reality of operating in CA will be that technologies must meet environmental requirements.
- Tom: Given CA's standards, and IMO-like standards, it's got to be an oxidant.
- Greg: Agrees that there are several gateway questions to determine efficacy: Is the system effective? Is there a technology that has been scaled up that will work at ship scale? And then there's the toxicological question for discharge and delivery. We can't really decouple [an evaluation of the] chemical from the system.
- Ted: There are mechanisms available (e.g. waste water treatment facility systems), but the question is if they can work or do work at the ship scale. The answer is yes: there are waste water treatment systems functioning on ships, not for ballast water [for sewage]. [In response to Greg's comment] Would add that the toxicological (environmental) question needs to address the ship impacts question as well.

- Maurya: That last question will be a large part of the report.
- Kevin: There are efficacy, toxicity and implementation questions. Efficacy and toxicity are a balancing act or a 2 step process. For implementation, shipboard application, technologies will need to be approved by classification societies in way of vessel and equipment safety concerns. For the few treatment systems which are in this process, these concerns are resolvable. As such, classification society construction related approval is possible and likely for most treatment systems. Part of implementation is construction concerns. For chemical application, generation onboard requires space and electrical power
- Jon: Current installations are currently generating data on these issues due to the IMO standards push.
- Greg (question): What is the extent to which pilot testing have been scaled appropriately. EX: some have been tested on only 1 tank – not sure if they can operate on a full ship scale [e.g. with all ballast tanks in use].
- Jon: There are several that have been scaled on a full ship scale, but not very many.
- Kevin [presented his revised matrix]: I would suggest a **Cost Metrics** Section. It's inaccurate to judge cost of technologies by cost per ton [of ballast water]. Need to consider vessel type. For example, some vessel classes may not typically discharge ballast in port but need a ballast treatment system for occasional or backup use. In this case, a cost per year of operations might be more accurate than cost per ton of ballast. For other vessels the best cost metric might be cost per ship call. One should also consider life cycle costs (capital dollars to install the technologies vs. operation, consumable and maintenance expenses). The life cycle process is a good way to evaluate the costs for putting a various technologies on a specific vessel class. A cost metrics approach should identify which technologies are practical for a given vessel class. For the **Tests and Approvals** section, a checklist may help. For toxicity most testing is appropriate in lab. Nationally, if a chemical is going to be sold, it likely needs a FIFRA registration. For use in a given state, that chemical will likely need to be registered in that state (might need more input from a toxicologist). "Classification" – talking classification societies; PVA = product design assessment (looks at mechanisms – electrical, flow, etc – is it responsible shipboard considerations); MA = manufacturers assessment (Can the supplier repeatedly build the item. Periodic factory tour to review). Completion of this Tests and Approvals checklist would result in the technology being ready for type approval (ready for sale, commercially available and approved). The **Installation Section** looks at the time it takes for vessel installation planning, equipment procurement and installation. Vessel installation plans (interface with vessel structure and systems) can take 1 – 2 months, with marine regulatory review (once new policies regarding ballast treatment systems are established) will probably be a 1 – 2 month review cycle. Lead is the time between order and delivery for equipment. This will range significantly depending on complexity of the systems. (EX: engines can take 24 to 36 months. A valve could take 4 wks -3 years based on complexity of the treatment system.) The shipyard process will vary significantly depending on what other work

is being accomplished and the complexity of the system. A simple chemical dosing system could be installed in days. A complex system (assuming no other construction efforts) could take 1-2 months.

- Jon: A big question that came up for IMO: What does "available" mean? Disagree that a small company won't be able to meet the needed output [demand]. If you have the design and have gone through the pre-qualification process a company, a small company can have manufacturers around the world pump out thousands of technology systems pretty quickly. The real issue will be supporting them the systems after they're delivered/installed on ships - for parts, service and resupply [e.g. for chemicals]. Availability shouldn't mean the ability to build –that is not an issue. The real issue is after-sale support.
- Maurya: Agree with Jon for the big guys. But most companies don't have their ducks in a row. Some of folks are doing it in their backyard
- Kevin: Even the large companies with a complete system designs will have significant effort determining who's going to do manufacture the equipment. This will require time to get contracts, perform QA/QC, interface with designers, etc. Treatment system company representatives will need to attend the shipyard installation effort before hookup, during building and at commissioning. Can't go from 0-1000 treatment systems just like that. Even for a simple system it'll takes 1-2 years to get a high volume production and installation support process going.
- Maurya: Agrees - the RJ Pfeifer took 3 times [modifications] to get it right. Installation and proper operation often take more time than planned.
- Mike: There is a reluctance [amongst system developers] to consider post-treatment element (e.g. neutralize byproducts out the pipe). They (developers) should be considering post treatment consequences.
- Kevin: One difficulty is that it's expensive. Two treatment processes [e.g. treatment and neutralization] can double the complexity of a system, making it more expensive, and more effort to install. This water quality requirement makes it difficult for companies to compete with another agency that doesn't require it. Need to level the playing field. Techcross got basic [IMO] approval without any dechlorination. Severn Trent doesn't have approval, but dechlorinates. How do you level the field?
- Ted: Severn hasn't asked for approval, it's not that they wouldn't be approved.
- Junko: Within G9 there's a suite of evaluation procedures for toxicology issues. Perhaps Severn Trent hasn't done it, but there are now systems in place to evaluate this.
- Ted: All basic approval says is that a system isn't so bad that they won't look at you. G9 final approval is where the real approval process will occur.
- Rich: Basic approval looks only at basic literature for toxicological impacts and lab testing. For chlorine, there's a huge existing literature, so it's easy to evaluate and feel comfortable to be relatively sure that it is okay. Basic approval is not really an approval, as it looks only at the chemical and doesn't look at the specific technology that a vendor will bring for approval.

- Rich: The G9 process also requires countries to apply -not the vendor. This presumes that the country's administration does a careful review of a package the vendor brings to it, and will forward on to IMO packages that they have deemed to meet the IMO G9. It's clear that many country's administrations are not doing adequate prescreening. That process does not resemble legal structures in US. The G9 is carried out under the [IMO] convention, but for legal purposes, that convention doesn't exist (has not been ratified, not enforced). Thus, the US can't do anything to meet its responsibilities under the convention. Constitutional authority issues come into play, there's no US agency to perform the functions required, until the convention is ratified. This is a problem for US developers – There's not a way to do this through the U.S. Other federal governments don't have this problem.
- Jon: 2 immediate barriers to ratification of Convention by many countries. 1) Not all relevant guidelines are finished. Many nations (UN member nations) legally unable to ratify until all guidelines are finished. Still without one guidelines (G2) – methodology incomplete. 2) Next factor, if a country hasn't ratified, most of those countries have in legal framework that they can't type approve. If they are a signatory then can type approve, but otherwise they can't approved techs without ratification. Other administrations can't ratify [technologies?] without convention ratification.
- Rich: Need to keep in mind, that because there is technically no convention, all of these G9 approvals don't have a legal basis. It only means that the system has been deemed to meet requirements specified in document. When convention actually comes into force, there will have to be a mechanism where past decisions are brought into legality. Many lawyers aren't sure how it will play out, particularly since the G9 process changes from meeting to meeting – methods and requirements change at every meeting. How they [IMO] will go back and reconcile old approvals with later ones (ex: Alfa Laval has gone through G8 tests vs. someone entering later under a substantially different approval testing process), and how IMO will level the playing field is in question. They may not.
- Kevin: So what will happen if an approved vessel (IMO) shows up in CA and wants to discharge?
- Maurya: It's very clear that it must meet CA's standard, or no discharge.
- Rich: It doesn't mean anything, especially without a convention in place. For the federal government, if there is evidence that testing was equivalent to U.S. Federal requirements, then it may be allowed. Otherwise, it's not allowable.

Break

Nicole: Where are we with these systems? Are any able to meet CA's standards? If not, what kind of time scale are we looking at?

- Jon: Need see what technologies have been installed on a ship. The other question is if it is being tested and how is it being tested? There are people that have

shipboard installations of one scale or another. You'll have to work backwards. As for who's releasing info now: Alfa Laval, Ecochlor, Severn Trent – the testing is predicated on testing with STEP program.

- Lucie: There is testing for chlorine dioxide (ClO_2) on the Atlantic Compass (ro-ro/container). This is both endpoint testing and time course testing on voyages from Newark, Baltimore, Portsmouth and back to Newark. We're looking at viability at discharge – and tests so far indicate that the ClO_2 systems meets CA standard. Toxicology testing is being done also. We found that going from bench scale to ship testing was totally different. We are also looking at differences between testing in-tank and at discharge. When testing/evaluating these systems, need to consider that all tanks on a vessel will outlet at one or a few given points – this means that when testing treatments against controls, the piping system needs to be taken into consideration and you may need to flush pipes before testing, if they have not been treated. So, it's a question of logistics. Also need to keep in mind that testing a vessel brand new without sediments in tanks is ideal, but results may be different from tanks that already have sediments. Have found that tanks already having sediments, we sometimes see 'regrowth'. Treated tanks with less sediment have very good results.
- Maurya: Should it be recommended to vessel owners that they should do a thorough tank cleaning before testing?
- Kevin: In drydock, common to clean ballast tanks out anyway. Ship effects are something to consider – good example here – that will affect results. Sea chests, piping configurations, etc. other ship effects need to be considered. Usage also.
- Ted: Regardless of what data you evaluate from ships, need to focus on testing samples at discharge. CA's standard is a discharge standard. Also, we have no faith in tank sampling (at ETV). The results have been extremely variable and unpredictable, even under extremely calibrated circumstances. Focus on in-pipe sampling for a hard measure on how well technologies are working. This will be difficult, because folks have only started looking at this.
- Jon: Believe it's safe to say that the answer to question 1 (will any technology exist) is yes. It is probably not there right now, or in a quantifiable state. There's enough indicative information data wise and corporate structure wise, that they will exist. As for dates [when it will exist] it's very nebulous. Many companies are viewing ballast water as a marketplace that will boom soon, but are waiting for these kinds of decisions [performance standards, evaluation methods, certification pathways] to decide when to grab a technology and begin ramping up production.
- Nick: If you go down list of standards, believes that for 50 microns, yes – technologies can meet it. For then next one, no. The methodology to test is not agreed upon – this is the key. For the less than 10 micron category (< 10 per mil – Bacteria) there is none that meets it, because there is no "viability" clause. Particles will always be there. For viruses – there's no testing that can evaluate this, because they test at 10^7/ml [sensitivity level?]. Current methods don't get down that far. For *E. coli*: yes. I Intestinal enterocci: yes. *Vibrio*: Yes.

- Tom: There's a difference between the analytical procedures used, vs. asking the question, "can it be done". Can't imagine that there's a procedure to enumerate the viral load in ballast water. A standard like that doesn't make sense from a monitoring point of view. The bacteria standard can be done (in waste water treatment systems). If you can't measure it, the question is why it's being used anyway.
- Kevin: Do these have to be [physically] testable? Would CA approve without actually conducting a test – e.g. could it do it by reviewing information?
- Rich & Ted: you run into problems. Their statute probably wouldn't let them do that because it implies use circumstances. USCG's statute may allow that – we only have to approve.
- Rich: Agree with Nick, but doesn't agree if it tells us anything about if technologies are available. Just identifies a systemic problem [of methods/protocol development].
- Kevin: Maybe for the ones [standards] that are possible to measure, we measure. For others we evaluate through a literature/theoretical review (e.g. bacteria counts)
- Rich: It seems that CA statutory language requires CA to do the physical testing.
- Maurya: agrees
- Rich: If you implement as Kevin says, thinks you'll be in court real quick
- Greg: Thinks Nick is right on for assessing numbers [if technologies can meet the standards currently]. Don't agree that they can't be measured. The issue is that there's no accepted approach. This is not a technological barrier, but a process approval for what constitutes appropriate technology.
- Nick: Yes. Testing is achievable, but we have not agreed on how to test.
- Greg: Defaulting to the literature is not necessary. As long as the process for measuring is identified, we can do it.
- Jon: So can't California specify testing methods [protocols] that must be used?
- Maurya: Yes – we are working on protocols.
- Ted: Fears that protocols will be based on input from folks that do water testing [water quality, waste water treatment]. ETV has encountered many problems during testing. When you do it, please involve appropriate folks.
- Maurya: Will proceed with the standards numbers as is. If it comes out that these are totally untenable, we can try to get back to legislature and try to change some things – e.g. if testing for some subset of the standards are not available, can we focus on testable ones.
- Kevin: What vessels want are approved systems with instructions that show the operator that as long as they operate per instructions, they are in compliance.
- Maurya: this is something that industry really needs to push on technology developers. That is only going to happen if industry demands it of the technology guys.

- Jon: That will be a commercial/practical reality down the line. The struggle is before that – how to determine initially that the equipment works legally. The first question right now from a ship owner is "which one is approved in the U.S.?" That will make systems "available".
- Kevin: Once that happens, a clock starts for when a technology is "commercially available". There will be a delay between approval and availability.
- Maurya: Yes. The primary question has shifted through the years. Now that we've got standards, the issue we get from developers/industry is now, "we can't develop a technology unless you tell us how to test it". Now is the time for developers to step up to the plate that do it.
- Ted: The Navies around the world (France, UK, Turkey) are reserving space and weight for future BW treatment systems in their ships, even though they have not yet procured those systems.
- Jon: Realistic to expect that there will be systems for all vessel types. Growing pains still need to be sorted out, but this is probably not insurmountable. It's still a timing issue for when they get through the pains.
- Kevin: If you only consider physical possibility: UV/filtration is commercially available for small vessels. Others (Nutech, Severn Trent etc.) should be commercially available in between 6 mo-2yrs. (will need 2 years to test for operational quirks), for larger ships. All will need some additional time to ramp up production to meet volume demands. As such, the IMO implementation dates look reasonable from a physical production standpoint. This evaluation is independent of efficacy review and independent of an approval process. These remaining issues [efficacy of systems & approval process] will add more time to the process.

Nicole: We've had difficulty getting information on toxicological impacts – Anyone have input on where we are on that?

- Jon: There's no system working on a technique that hasn't done at least some toxicological testing. Maybe data isn't complete for CA purposes. Testing has been opportunistic. There's data to indicate that will be ecologically acceptable.
- Lucie: We need to provide information on what testing is acceptable. Look at Washington as a guide for testing – this is what is needed. Needs to be agreed upon.
- Rich: The USCG doesn't test for toxicity and has deferred to EPA. EPA is not dealing with it yet.
- Maurya: What are you doing with the STEP evaluations and toxicity then?
- Rich: Telling them [developers] to talk to local jurisdictions about acceptability of discharges.
- Ted: There are provisions in ETV evaluations. Whole effluent testing must be conducted, but there is no information on the criteria for testing.

- Maurya: For CA, if a chemical is not on a "List" (e.g. the Ocean Plan), then there's no guidance.
- Ted: It'll be important to specify input water conditions before testing – existing water quality issues will influence output test results.
- Kevin: WA State's process looks complete (from an engineering standpoint) and good – any opinions on it? (Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria, Appendix H, http://www.ecy.wa.gov/pubs/9580.pdf)
- Lucie: Ecochlor has chosen to test according to WA guidelines because it was felt that the guidelines were complete and available.
- Mike: Looking at single ships with a single treatment technology is a totally different process from a type approval process. A "no significant impact" finding for STEP means only that one ship with one experimental BWT system visiting one U.S. port, say, 10 times per year, does not pose an environmental threat. This is a long way from a type approval that would include some sort of review and approval for residual discharges on a much larger and more widespread scale.
- Jon: Is there a transitional language for the CA regulations that dovetail with a Federal program if it comes into effect.
- Maurya: If a national program that is comparable to the state program comes about, we report on the comparison to the CA state legislature, and then make recommendations (e.g. CA program can go away).
- Jon: So there is a responsibility [for California] to try to bring pressure for a federal program to come into existence. A fragmented state by state program isn't desirable. What is the status on federal level?
- Rich: USCG is doing a rulemaking and is well into it. USCG is not at a point to tell the public what the standard will be. That will occur during the announcement of proposed rulemaking. However, our standards will not preempt states form having their own programs. Really, it is up to Congress to decide if they want to change the federal landscape, and they have been unable to do this thus far. Only one bill has ever made it out of committee, of many that have been introduced.
- Jon: Do you think that what has occurred with STEP applications have clarified the questions here?
- Rich: No. We're in the same place or less informed than CA.
- Jon: Ship owners are looking at STEP program approval as the same as a type approval, in the absence of an actual approval process.
- Rich: There is only one system that has gone through formal testing (Alpha Laval). The problem is that the only evidence available that they have met DNV type approval is a statement by DNV that "it passes" the D2. No data or scientific results have been made available on results on methods, assumptions, etc... We can't evaluate what that means. I've only seen select data at Alpha Laval's choosing – which brings forward lots of questions of validity of that testing.

- Maurya: Agree – for me, anything that hasn't met USCG or CSLC acceptance won't work in CA.
- Kevin: When Alpha Laval comes out with an announcement that they have DNV approval, many [shipping] companies will take the bite [and install their system].
- Maurya: That is why CA has been adamant that Federal approval is really important – otherwise installation won't do shippers any good.
- Tom: It's unfair to compare Alpha Laval who has the finances to move forward with technologies that might work, with small companies who don't have those resources [and are waiting for a sanctioned approval process] and will suffer. They can't move forward, because they aren't protectable against a similar competitor. Large companies don't need approval to move forward, they are moving forward regardless because they can protect themselves. It seems unfair to small companies to force them into toxicology testing, with something that's been tested all over (e.g. chlorine) through other applications (e.g. waste water treatment, power industry). From a toxicity point of view, residuals will be the same from a ship – why would they be different? Novel biocides will need testing.
- Maurya: What is the rationale for dealing with shipboard issues so differently from waste water treatment discharges?
- Tom: People in that arena (EPA) don't work in this area [with ships] – its too different, different expertise, different people. Regulation though EPA here wouldn't be manageable, or good.
- Jon: There's a perception in the media and some circles in the environmental community and in the world of traditional water treatment general trend to move away from chlorine and looking towards new technologies in the waste water treatment world. There is a stigma in some environmental circles and perception presented in the media that chlorine is a thing of the past and we should be looking towards innovation.
- Kevin: It's stationary vs. mobile sources. For stationary sources, we can model discharge effects. With a mobile source, the community that a vessel calls on doesn't have opportunity to test in the same way.
- Ted: That said, there's no aversion to chlorine in the [shipping] industry. Nor for the regulatory agencies, because regulations exist for chlorine. There are regulations in place.
- Rich: The same thing happened with IMO. There's a group that is adverse to a use of a new group of chemicals. There are separate sectors working to the same anti-chlorine perception – slowing development down.
- Jon: But it [chlorine] is one of the best documented methods for treating things. We know how it works & its quantification of negative impacts. It has been acceptable for years. For an interim solution at least, it's a good starting point.
- Maurya: The issue has been a frustration for CA – the best available technology is chlorine, but there is a huge resistance to it.

- Ryan: EPA views the NPDES process as a shield for a company's responsibility to protect water quality. When it comes to treatment systems, the agency [EPA] has the responsibility to issue NPDES permits that are protective of water quality. At that point, a citizen's suit goes after EPA, not ship owners. Until Sept 2008, ships are exempt from NPDES permits.
- Tom: Has CA considered looking at waste water treatment/industrial waste discharge standards in general, and moving them onto ships, without a permitting issue? The shipping industry is like any other industry at the dock and must follow the discharge requirements like any other industry. Look at chlorine limits for industrial waste discharges, and convert to use for ships. This approach could be a beginning point. Many [discharge standards for many constituents in waste water or industrial waste] won't be pertinent, but at least for those that are; you've got the same matrix on them.
- Kevin: Could use shipping lanes as a discharge zone.
- Tom: Discharge standards (industrial) are based on water quality standards. Can't imagine anything from a ship will affect standing water quality standards.
- Maurya: We would look at the strictest existing water quality discharge standard in CA, and extrapolate to ships.
- Jon: Clearly, these issues have already been well investigated, tested, etc…why recreate the wheel?
- Maurya: Notes that we have been getting little guidance from CA state water board.
- Ted: The toxicity thing for ships seems no big deal compared to industrial discharges.
- Rich: Does SLC have authority to regulate a discharge (toxicity) to state waters? Discharge standards exist for much greater volume. If we're suppose to pay attention to environmental effects, a good bit of logic would be to base it [ship discharges] on what's already allowed. If we maintain that standard, it won't be a significant increase on status quo. Water Board has already said what's acceptable for discharge, and you wouldn't be out of line with that.
- Maurya: Because of the lack of participation from Water board – they have offered no assistance in evaluating toxicity.
- Ryan: Look at wastewater discharge standards. Many, though not all, elements [discharge constituents] will be analogous.
- Kevin: USCG has authority over ships calling to US water for oily water discharges, & MSD levels. It would be a logical next step for U.S. Coast Guard to determine a discharge standard for ballast water toxicity. SLC could then take care of state issues starting with U.S. Coast Guard discharge standard and framework, and modify the standard as needed. This scenario follows an existing framework for regulating oily water and MSD discharges.

- Maurya: Could be helpful, but CA doesn't have the luxury to wait for the federal government to put these types of processes in place.
- Tom: But the other way [Ryan's comment], you're not dictating anything new – totally in line with existing standards.
- Rich: If discharges were administered through NPDES instead, every port may in theory have a different discharge standard [which is undesirable].
- Ryan: That is how NPDES permits work ideally [conceptually], but general permits don't in reality.

Nicole: Wrapping up – Are there any important issues we should discuss that we haven't yet?

- Nick: if there are tests that are established, have statistics been considered to determine compliance?
- Lucie: There is a difference between what Scientists consider acceptable, and what will be accepted legally. Whatever you come up with may not be accepted by all scientists. In application you'll need tests that will give you a good idea of what's happening. Scientists should be involved in this process of selection, but other components of the community should participate in the decision of what is do-able/practical and will be legally binding.
- Jon: In response to Maurya's request to be pragmatic. Given that you have to live with these discharge standards, and have some latitude on how to get there (interpretation), lets try to put it in a box in the near term, and tell the industry what [kind of information on treatment technology systems] you'd like them to bring you. Industry will package it according to the variables you ask them to. Then you will have a picture of what's available, and what has to be developed. Jon volunteered to help spearhead that effort.
- Tom: Response to Lucie's comment. As an agency, you have to have some input back into these numbers – they are non-sensical/arbitrary. There needs to be some push back by agency too.

Adjourn

APPENDIX C

California State Lands Commission
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Ballast Water Treatment Technology
Technical Advisory Panel
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California State Lands Commission
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**Indicates participation via conference line

DEVELOPMENT OF TREATMENT TECHNOLOGY ASSESSMENT REPORT

Per the California Coastal Ecosystems Protection Act, the California State Lands (Commission) is required to conduct an assessment of the efficacy, availability, and environmental impacts, including water quality, of ballast water treatment technologies. In preparation of the report, Commission staff conducted a literature review including

scientifically reviewed literature, white papers, grey papers, and manufacturer sponsored promotional brochures and documents. Additionally Commission staff hosted a technical workshop in Boston in May following the Fifth International Conference on Marine Bioinvasions. A draft of the report was made available to the Advisory Panel on August 24. Comments were received through late-September, and on October 4 a revised draft and a response to comments was provided to the Panel.

TIMELINE

A final draft of the report, incorporating suggestions from the Advisory Panel meeting, should be completed by November 8. The final draft will be presented to the Commission on December 3 in Sacramento. The final draft will be posted on the SLC website at least 10 working days prior to the Commission meeting. Comments on the final draft can be submitted by the Panel and the general public prior to and at the December 3 Commission meeting. The Panel will be advised of when the report is posted to the website and of the details for the Commission meeting.

OVERVIEW OF TAG QUESTIONS/CONCERNS

Each Panel member was asked to voice their questions or concerns (if any) related to the draft report emailed on 10/4/2007. In summary, they fell into the following categories:

Legal Issues:

- Potential conflict between California State standards and Federal ballast water management regulations. Will technologies compliant with California law still have to exchange ballast water to meet Federal requirements? (Swanson, Schilling)
- Ballast water requirements of other countries, and information on the international nature of the issue are missing and should be included (Ward)

Water Quality Requirements and Issues:

- Particularly in light of the submitted comments from the State Water Board, and the EPA lawsuit, what will the process be for implementation and approvals for active substances (Holms, Everett, Ruiz)?
- Who will implement an approvals process, and what are the implications for the California performance standards implementation (Holms, Everett, Ruiz).
- With regard to comments made by the State Water Board regarding active substances, how will technologies that meet California's standards and water quality requirements be applied in other states or countries (Berge)
- Concerns of the State Water Board were submitted in a revised draft sent to the Panel (Ward

Onshore treatment dismissal: Premature dismissal of onshore treatment (Cohen, Ward)

Implementation delay: Basis for the one-year delay (Cohen)

System approvals and compliance protocols: Approval of equipment, and discharge testing (protocols) for verification of compliance (Cohen)

Effectiveness of interim management: Ballast water exchange (Fredrickson)

Economics: Removal of information on lack of investment as a reason why advancement of technologies have been slow (Cohen)

LEGAL ISSUES (FEDERAL/STATE CONFLICT)

Though Commission staff recognize the desire for consistent standards with the state/international community, California's standards were set by State legislation and the Commission does not have ability to change them directly. At the Federal level, several activities may impact the Marine Invasive Species Program (MISP) (bills, law suits), however, the Commission must proceed with what it has been legally mandated to do, regardless of these other activities (Gregory, Falkner, Dobroski). This point should be better asserted in the report (Bolland).

If EPA loses its appeal and NPDES system of regulation for ballast water discharge moves forward, or if any of several federal bills passes, it is unknown what will occur (Berge, Ward). The State program and State standards may go away, particularly if preemption language passes with any of the pending Federal bills (Gregory, Bolland). The EPA could dictate minimal standards, as it does with the Clean Water Act, allowing local standards to be stricter (Cohen). In that case, the State Water Resources Control Board (SWRCB) could adopt a general order directing folks to Commission standards and requirements, in which case the current program may not be eliminated (Ward). If the SWRCB and/or the Regional Boards become responsible for administering the program and/or standards, several issues would have to be resolved: Existing water quality control plans (Basin Plans) would have to be reviewed. There is a policy for implementing NPDES permits, the State Implementation Policy, that must be reviewed and taken into consideration (Feger). Possibly, a general permit could be put forward directed towards specific age and types of vessels (Ward).

Other Notes:

- (Reynolds) It may be relevant to discuss in the report how implementation may be impacted by potential federal regulations

IMPLEMENTATION DELAY (from 2009 to 2010)

The purpose for proposing a one year delay for the first implementation date was to allow time for the development protocols to verify compliance (<u>not</u> certification protocols), and to provide time for technology developers to test prototype systems against California's standards (Dobroski, Gregory). Because the standards have very recently gone through legal process (approved by the Office of Administrative Law on October 15, 2007) companies have not been testing to CA standards, but to the much

weaker IMO standard (Falkner). It appears that many technologies are very close to meeting California's standards, and that a major holdup is that the standards haven't been on the radar long enough (Dobroski).

Ship owners will want to have a set of compliance testing protocols, so developers can demonstrate that a system meets the out-the-pipe standard. Only then can owners begin the process of installing systems on ships. Though they need the standard, they also need protocols for testing systems, since different testing methods can yield different results (Reynolds). Even though protocols may change through time, a consequence of not having a testing procedure in place was that Staff could not tell if any system met California standards due to the variety of testing methods/reporting used, and because most developers were testing to the IMO standard (Cohen, Falkner).

It was also noted that a delayed implementation could be well used to resolve a process (through the Commission and SWRCB) through which systems that use active substances could be deemed acceptable for use in California (Ruiz) (see notes below).

In addition, the delay would allow for the development of guidance testing protocols to assist developers as they test against California's standards, so they may "self-certify" their systems for potential buyers. These will not be used by the State of California to certify systems (Gregory). Ideally, Staff want to avoid a situation where vessels arrive to the State with treatment systems that developers claim meet the California standard, but don't. Discharges in that case could cause more harm than good (Falkner). The delay was not driven by the lack of techniques for measuring the <10 micron count standard (Dobroski).

There was concern that one year may not be adequate to complete these tasks, if compliance protocols are projected to be completed by mid-2008, and that one year delays will continually be requested/proposed (Bolland, Cohen). The IMO suggests that prototype systems be tested for 6 months to capture at least 3 seasons. Following that, a new clock starts for developers/manufacturers to conduct verification, equipment adjustments, design efforts, production, installation, shipyard availability, etc (Reynolds).

At this point, Staff believe that the desired goals can be accomplished with a one year extension for the first implementation date (Gregory). The number of vessels that come under the first implementation date is very small. Since 2000, there have been approximately 250 vessels that have entered California and discharged ballast water in this size class (<5000MT) [Note: 695 unique vessels (dischargers and non-dischargers) in this size class have called on California ports between January 2000 and June 2007.] If we assume a 20-year replacement cycle and that 5% of the vessels (695 over 6.5 years) may be replaced per year, we can expect to see approximately 6 new vessels in that size class subject to the 2009 (2010) implementation date requirements (Falkner, Reynolds). Most of these won't hit the water until 2010 or 2011. Compliance verification protocols and suggested testing guidelines for technology developers will be developed in consultation with USCG, maritime engineers (e.g. Spencer Shilling, Kevin Reynolds, etc), by 2008 (Falkner). It's unlikely that subsequent delays would be granted

by the Legislature (Gregory). Both the IMO and federal bills are considering various implementation delays (Falkner, Everett). The Commission does not anticipate requesting another delay, even if the industry requests one (Holms, Gregory).

There were also many questions and concerns regarding how technologies that utilize active substances will be deemed allowable with regard to water quality issues (Ruiz, Everett, Berge). Many of the most effective/promising systems utilize active substances, but without some procedure through which developers can determine if their systems can be assessed in this regard, there was fear that technologies may not move forward, and may be another source for delay (Ruiz, Everett). Companies will not want to buy and install systems on ships unless they are guaranteed that it will meet both the biological standards and water quality requirements (Reynolds). Specific questions and points included:

- How does a discharge permit review for active substances get done, and how long will it take (Ruiz, Everett)?
- How will the State determine if someone is in compliance? (Includes verification protocols, how many tests, where is the sample taken, etc). A step by step checklist should be provided to technology developers so they may test systems, as they won't be able evaluate this through any existing documentation (e.g. California Ocean Plan). (Ruiz)

It is currently not clear how active substance discharge compliance will occur (Ward). The SWRCB and the Regional Water Quality Control Boards don't currently have a permit process in place for mobile entities like ships. Generally, Regional Boards don't prescribe specific technologies to meet specific established permit limits, but they do have dischargers self-monitor and evaluate whether they met their permit limits. Complying with permit limits for some pollutants can be difficult to achieve and some permits have been written with compliance schedules and a date by which they will comply with the limits. Applying these procedures to mobile ships would be a totally different animal, and won't be a quick issue to resolve. It should probably be a process that the Boards review, while the EPA lawsuit is being resolved (Feger).

For issues specific to ships (unpredictability of volumes of discharge, timing of discharge, etc.) it seems reasonable that the SWRCB may implement an NPDES process, as it addresses similar issues for onshore facilities. However, it is not clear how this will happen (Berge, Ward).

The USCG and California are aligning protocols for compliance testing, which should help get the word out to developers. However, since California isn't planning on doing type testing (certifications), protocols won't be aligned in that respect. For the water quality/active substance issue, however, it's not known if alignment will occur, especially if California has varying water body-specific requirements (Berge, Everett).

SYSTEM APPROVALS AND COMPLIANCE PROTOCOLS

Following much discussion with colleagues and lawyers, the Commission has decided it will not be type approving systems/equipment. The technology developer will "self-certify" compliance with California's standards. Vessel owners will be responsible for asking the developers how standards have been met. Part of this will be reflected in regulation. A separate issue will be the development of end-of-pipe testing for compliance (Gregory).

Compliance for the biological NIS performance standards is currently under the jurisdiction of the Commission who also has the ability to impose civil/criminal penalties. Currently the Commission is directed to inspect and sample at least 25% of all arriving vessels. The 2006 Coastal Ecosystems Protection Act also allows other entities to impose civil penalties (Holms, Falkner). Water quality compliance for active substances would be deferred to the State and/or Regional Boards (Berge, Gregory). Self-certification of treatment systems will be the complete responsibility of the technology developer, and will not involve the Commission (Cohen, Gregory). There will be a regulatory need to direct the certification process, but not define it. State will only develop non-regulatory, non-certification guidelines for testing (Gregory). Ideally, a 3rd party would certify testing for the technology developer (e.g. Lloyds), but would not be submitted for regulatory review by California. This is so developers can have the latitude to select who does their own testing (Reynolds, Falkner). It should be clarified that self-certification is not legally required, but is an effort to assure quality products (Cohen). It is not clear if labs will be certified to perform the testing or not (Morin, Gregory).

Other Questions & Suggestions:

- (Ward) The FDA has testing techniques to test pathogens rapidly (especially Vibrio). Also, there was no reference in the report to the California Department of Health and their capabilities. The State Water Board is teaming up with thee groups to investigate such methods.
- (Bolland) There should be an effort so the SWRCB will be actively involved in development of protocols, in anticipation of whichever way the legal situation pans out
- (Holms) Will the Commission have the capacity to implement this program or collaborate/delegate components to others? Gregory: The MISP has a staff of 19 (inspectors, scientists, database management), and the State Water Board has one person year (PY) paid through the MISP funds. There may need to be a boost with a few more scientist staff, but the resources should be there. If the SWRCB samples for active substances testing, the Commission can assist them, or get the samples for them.

OMISSION OF SHORESIDE TREATMENT

There was a concern that a review of shoreside technologies was prematurely dismissed from the current report, and that the argument that they were overly costly and not practicable for vessels that discharge before coming to port were not

adequately evaluated or proven. Onshore systems can be built to meet the standards (Cohen).

The 2006 Coastal Ecosystems Protection Act required assessment of currently available technologies. All of the current prototype treatment systems are ship-based, and there has not been any prototype shore-based systems developed. Thus, the emphasis in the report was on ship-based systems, as they were the only ones currently available (Dobroski, Falkner). Shore-based systems were not included in this report because the legislative intent evaluating technologies 18 months before each implementation date was to determine what systems might be utilized by the time each implementation deadline arrives. There was no data to evaluate the effectiveness of shore-based systems (Falkner).

Evaluations have been completed for California and Seattle and overall conclusions have been that shore-based or barge-based systems would be practical for specific vessel or trade route groups. However, they are not universally applicable for a system like Puget Sound because vessels must discharge long before arriving since cargo loading rates greatly exceed deballasting rates (Reynolds). Though no technology should be dismissed, from the viewpoint of shipping companies that have vessels transiting around the world, a shoreside technology would have to be available everywhere vessels go. Companies want to be able to go anywhere and reduce invasive species discharge, including small 3rd world country ports that may not have the resources for such facilities (Berge). For future implementation of a shore-based system, it would be the ports that would have to initiate such efforts (Swanson).

Other Notes/Suggestions:

- (Holms) A couple of sentences could be included stating that shore-based might be attractive in the future.
- (Cohen) It may be good to get someone to gather information on the feasibility of onshore. This may or may not be CSLC.

EFFECTIVENESS OF INTERIM MEASURES

Justin Fredrickson (CA Farm Bureau Federation) wanted to be filled in on the effectiveness of current management measures (ballast water exchange), and if enough is being done to curb species introductions. Specifically, why there is a 55-99% range for effectiveness of ballast water exchange.

Gregory Ruiz reported the results of a recent NOAA technical report completed by the Smithsonian summarizing reasons behind the wide variance reported for exchange efficiency. Much variation results from how people have estimated how effective exchange is. Studies that report at the low end of efficacy are typically not from controlled experiments or have not looked at how organism composition has changed (e.g. how inshore organisms are replaced by offshore ones). Many of these compare average organism numbers between ships that have and have not exchanged. This method isn't very useful, because the number of organisms in a tank can vary widely,

depending on how many are in the port waters at a vessel's origin, or ballast intake point. For experiments that compare control ballast tanks (unexchanged) and experimental tanks (exchanged), reported efficacy is much higher. For these, the range is between 80 to 99%. Even in these experiments, there are variations in efficacy related to the volume of water that is moved during exchanged. Generally, exchange is more efficient when a larger volume of water is involved. Bottom line is that exchange is very effective when conducted properly. Though one must keep in mind that even after a proper ballast water exchange, a fair number of organisms can remain (e.g. if you have a billion to begin with, there will still be quite a few if efficiency is 95%). (Ruiz)

Exchange efficiency is dependent on 2 components – volumetric efficiency (flushing efficiency) and organism efficiency (how many organisms remain). Even after a proper exchange, many organisms may still remain depending on the flow characteristics, or chemical kinetics of the tank, due to ballast tank shape and ballast water intake and outtake positioning/construction (Reynolds). Also, organisms are present in the open ocean, and these can be taken in during exchange (Ward).

There was some confusion over the scope of the Marine Invasive Species Act/Coastal Ecosystems Protection Act (Ward). Both pieces of legislation apply to ocean, estuarine, and fresh waters of California (Falkner).

Historically, most parties involved agreed that ballast water exchange was a good starting management measure, but a better future solution would be treatment technologies. Ideally, the long term use of technologies will lower risk of invasions in the Delta and elsewhere. The reason for moving forward with the timeframe for performance standards in California was to push forward the development of treatment technologies (Bolland).

ECONOMICS & THE SLOW ADVANCEMENT OF TREATMENT TECHNOLOGIES

Specific numbers relating to the ability of the shipping industry to bear the cost of treatment technologies were removed from the original report draft, due to comments that statistics from large companies such as APL and Maersk don't represent many in the industry as a whole. Instead, statistics comparing the costs of systems in comparison to the cost of a new vessel (an increase of 1-2%) were used (Dobroski).

It was noted that it was helpful that the report framed the costs of treatment systems with respect to the costs of environmental damage caused by NIS. Though no one knows the full costs, they are probably understated here. Conceptually the costs that the industry will bear for technologies are comparatively small (Bolland).

Andy Cohen felt that the report should state that a lack investment from the shipping industry has been a primary reason for the slow development of treatment technologies. In response, it was noted that the shipping industry, while certainly not innocent, did not have the expertise and regulatory backing to develop such systems. When investing and/or providing ship platforms for technologies, the industry needs to do it in with a

state/federal/international body so there is legal credence for activities. To its credit, whenever there has been an opportunity to put a prototype system on a ship, a vessel, funds, or resources have been put forward to engage those systems (Berge). Another significant non-financial hurdle has been the inability of regulators to get permits together so the system can be used. There may be a ship and technology, but a permit still must be obtained to use it. Many projects have faltered because of this (Reynolds). It doesn't make sense for a company to put a system on a vessel if the USCG won't approve its use (Swanson). Also, it's notable that standards (IMO) have only been out for a very short while, and an amazing push in treatment technology development has occurred within the last 2-3 years in response (Falkner). Rather than point the finger, it is more useful to indicate how much technology development has cost to date, and how much is needed for the future. The issue is that more funds are needed. The simple point that investment has been lacking is worth making, however. Finger pointing is politically dangerous and not helpful (Holms).

The treatment technology realm is a huge cottage industry waiting to happen. Development companies are waiting to step in and get rolling. Eventually, the shipping companies will pay for systems and the R&D funds used to develop them, as those costs will be folded into the costs of the systems (Berge).

THANK YOU AND ADJOURN